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Fukuzawa et al.

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[54] **COMMUNICATIONS SYSTEM/METHOD
FROM HOST HAVING VARIABLE-LENGTH
FORMAT TO VARIABLE-LENGTH FORMAT
FIRST I/O SUBSYSTEM OR FIXED-LENGTH
FORMAT SECOND I/O SUBSYSTEM USING
TABLE FOR SUBSYSTEM DETERMINATION**

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G06F 12/00; G06F 15/16; G06F 13/12

[52] **U.S. Cl.** **710/65**; 710/3; 710/4;
709/200; 709/217; 709/245; 709/246; 711/221

[58] **Field of Search** 709/200, 213,
709/216, 217, 245, 246; 710/3, 4, 65; 711/221;
395/200.3, 200.43, 200.46, 200.47, 200.75,
200.76, 823, 824, 885, 421.11

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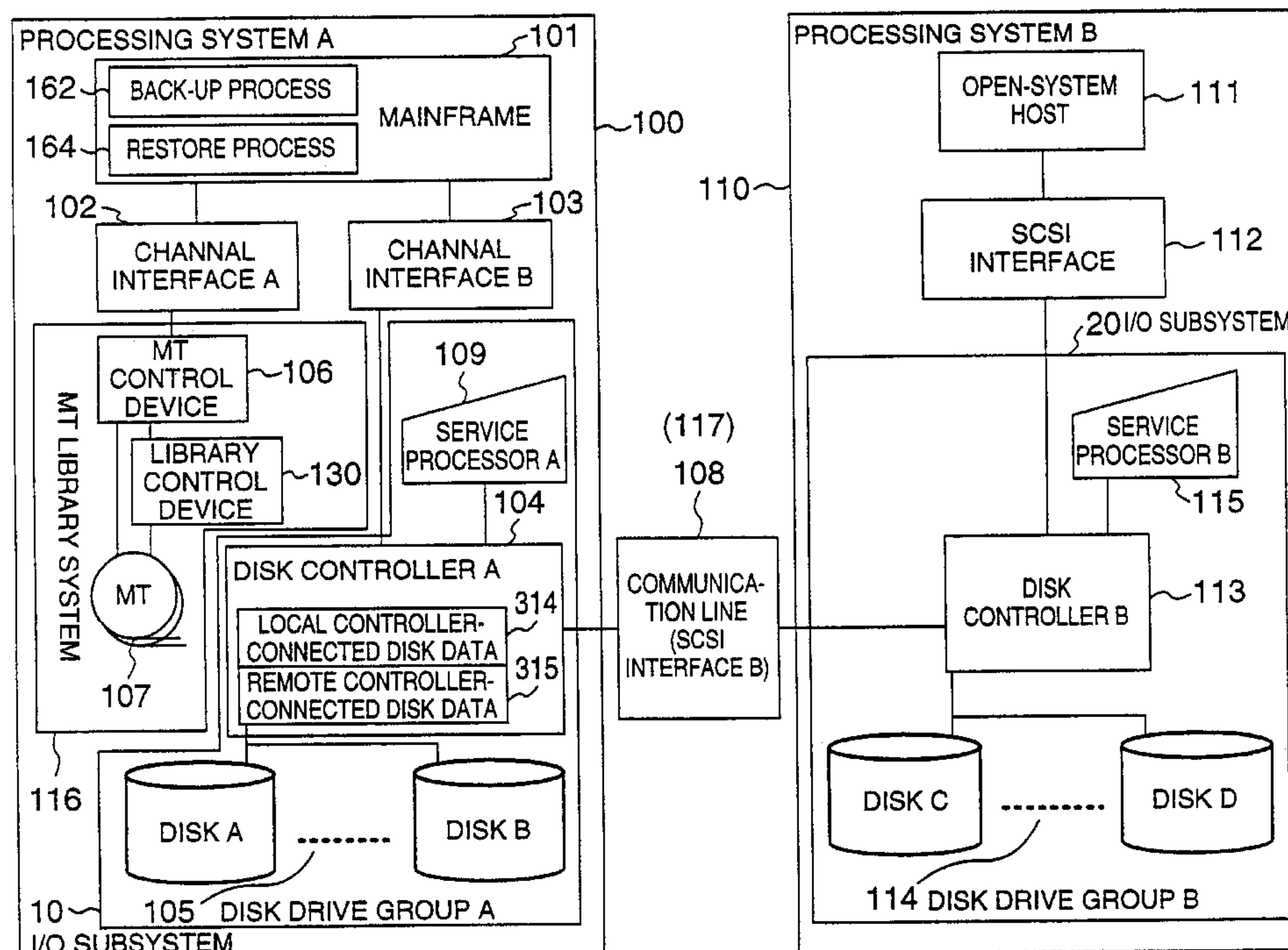
Assistant Examiner—Tanh Nguyen

Attorney, Agent, or Firm—Antonelli, Terry, Stout & Kraus,
LLP

[57] **ABSTRACT**

In a heterogeneous computer system, a heterogeneous input/output system and a data back-up method for the systems, an I/O subsystem A for an open system and an I/O subsystem B for a mainframe are connected by a communication unit. In order to back up data from at least one disk connected to the I/O subsystem B in a magnetic tape library system and in order to permit the mainframe to access the data in the I/O subsystem B, the I/O subsystem A includes a table for assigning a vacant memory address in a local subsystem to the memory of the I/O subsystem for an open system. A request of variable-length record format received from the mainframe is converted into a fixed-length record format for the subsystem B. The disk designated according to the table is accessed, and the data thus obtained is sent to the mainframe and backed up in the back-up system.

8 Claims, 7 Drawing Sheets



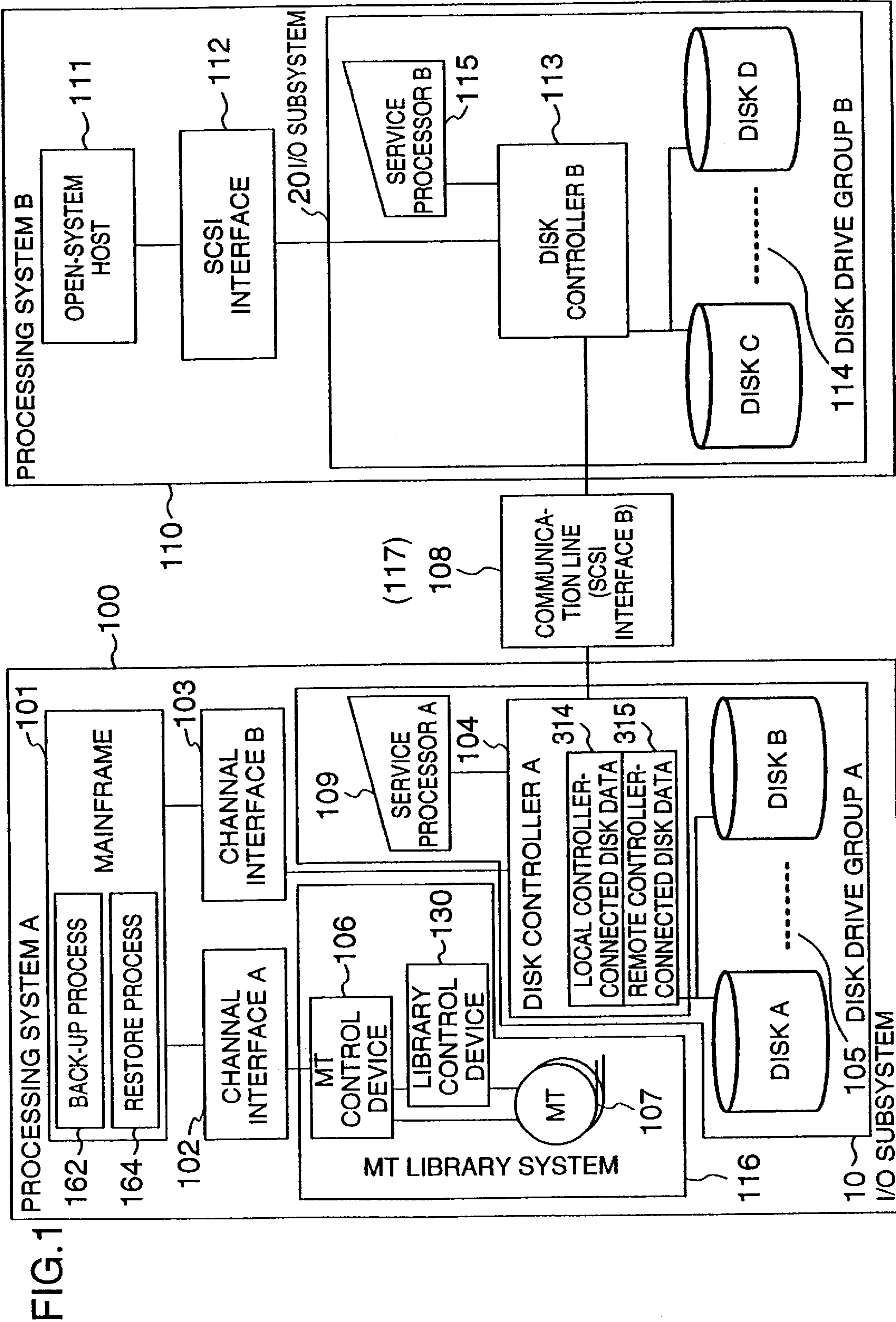


FIG. 2

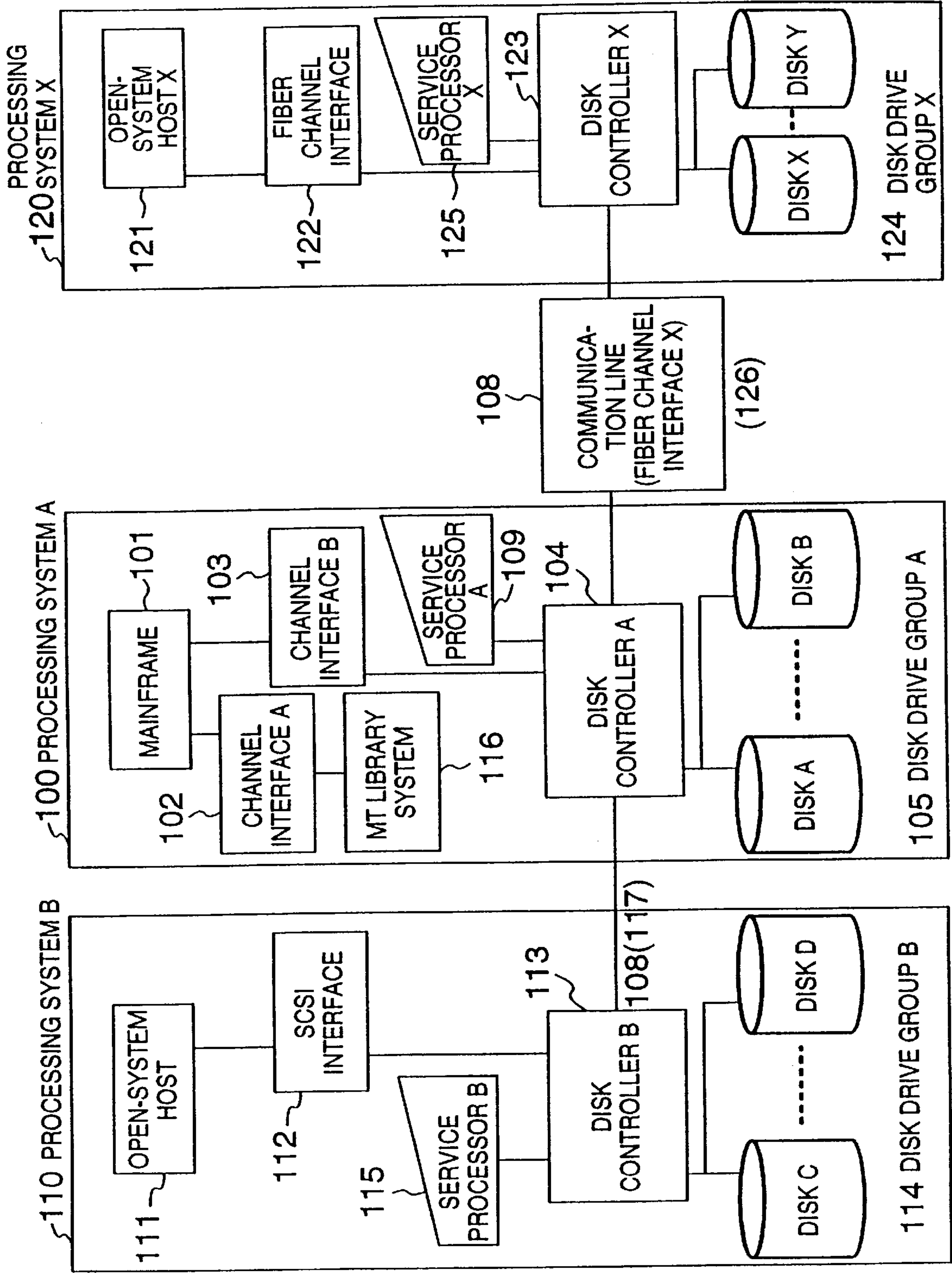


FIG.3

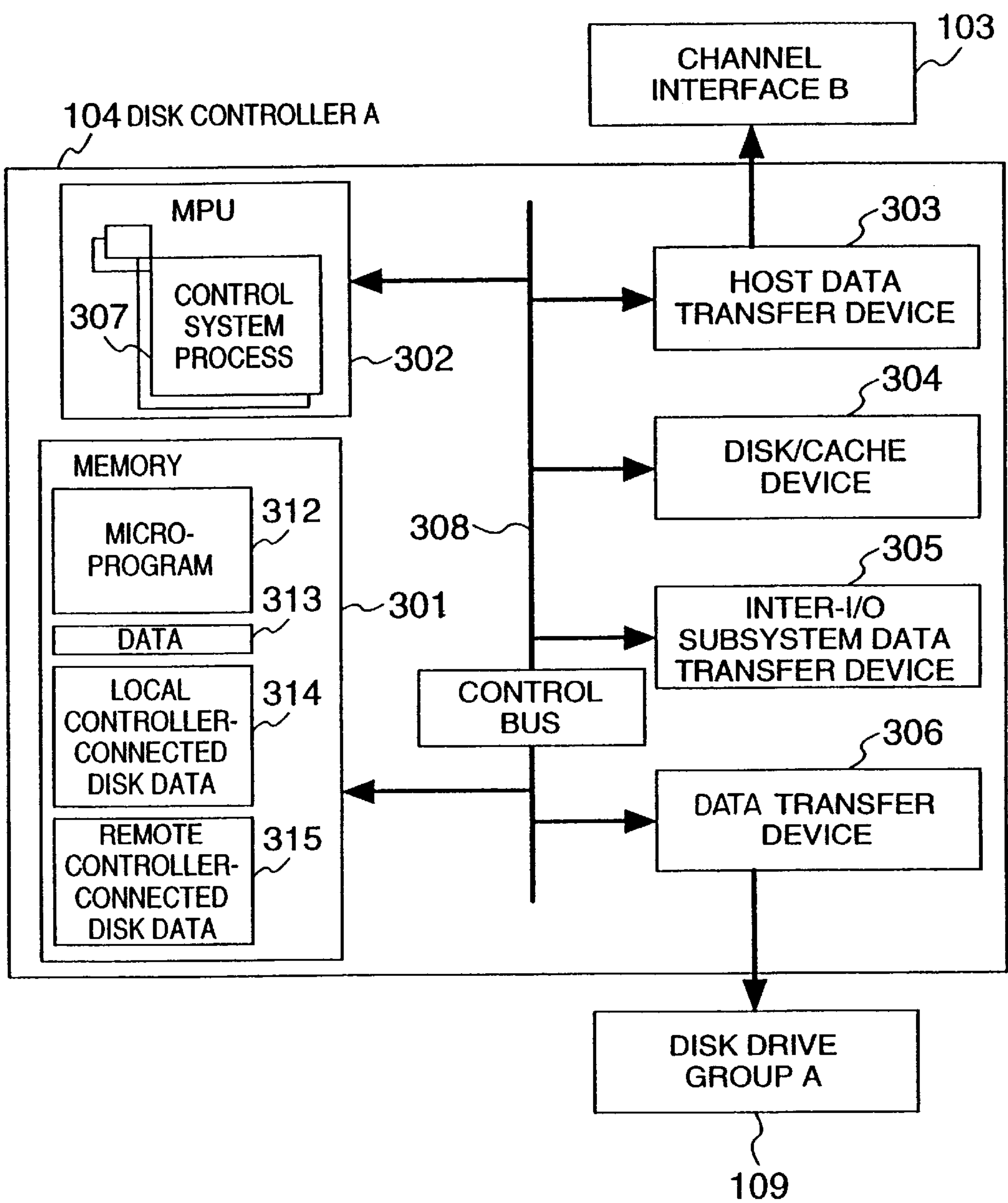


FIG.4

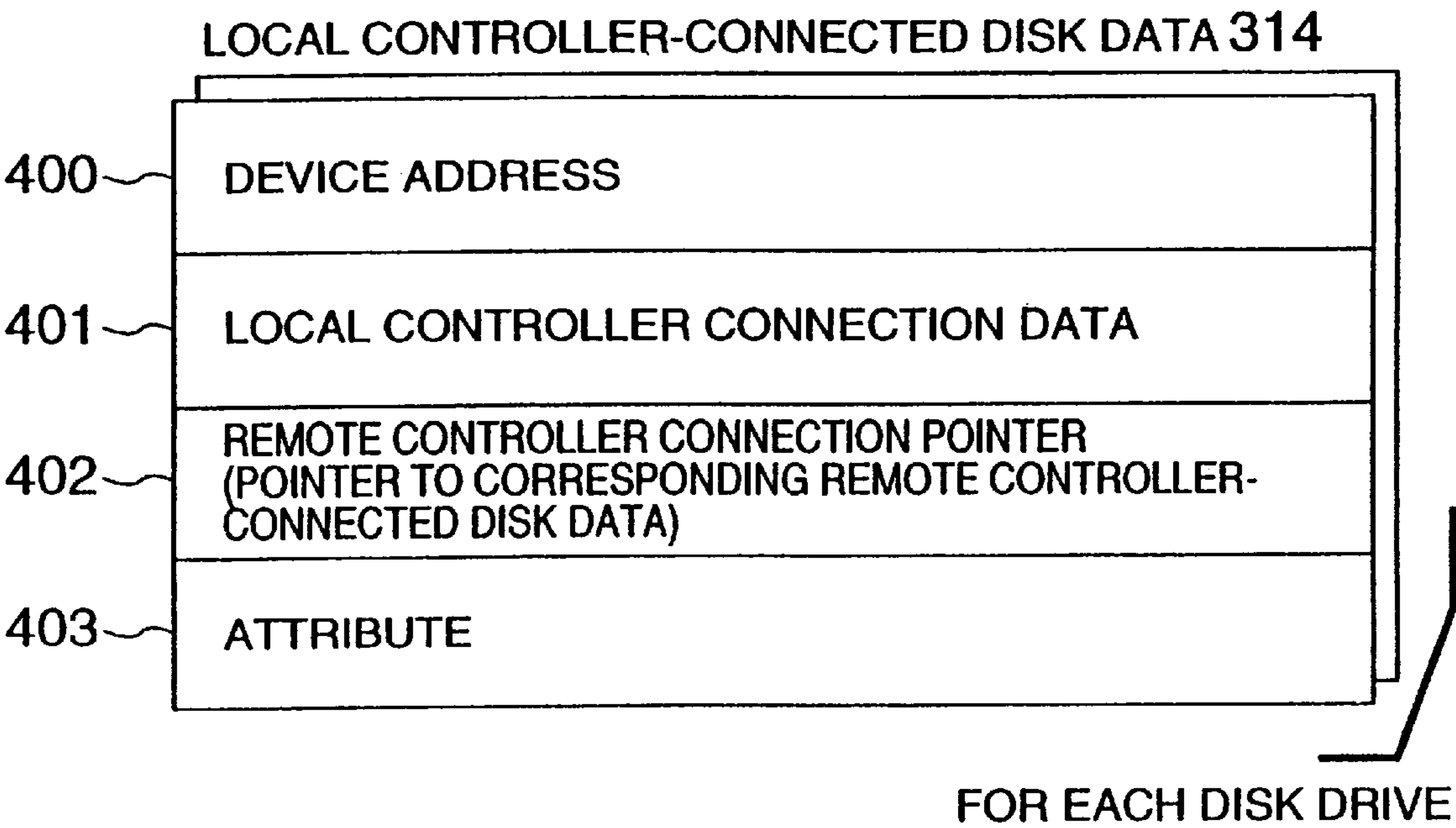


FIG.5

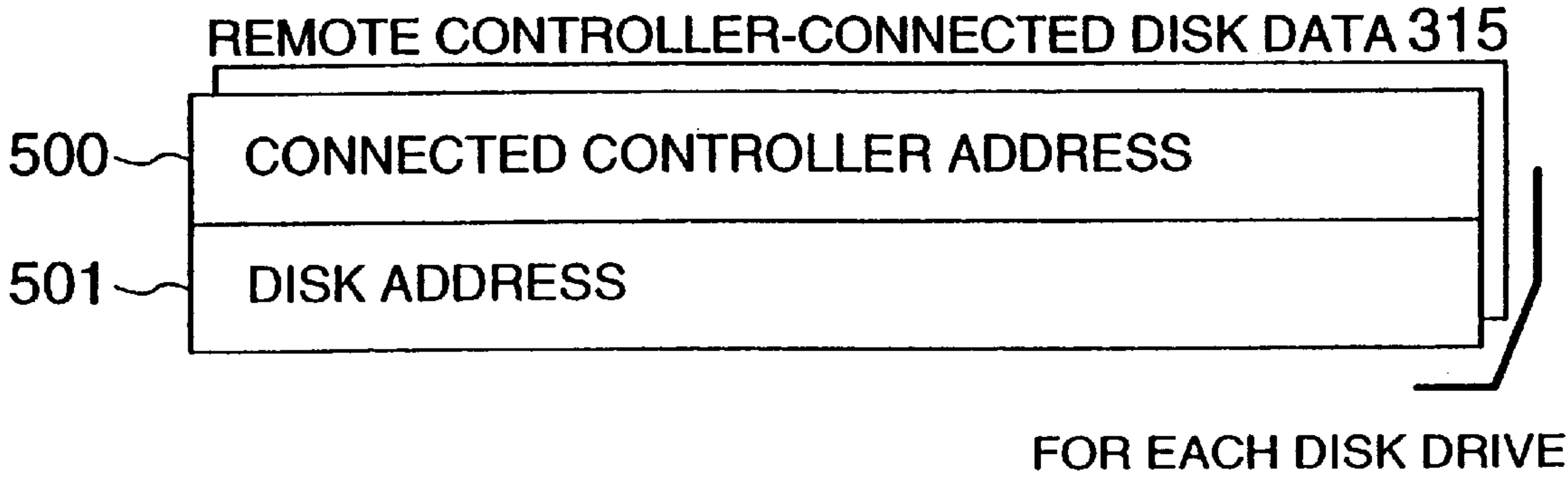


FIG.6

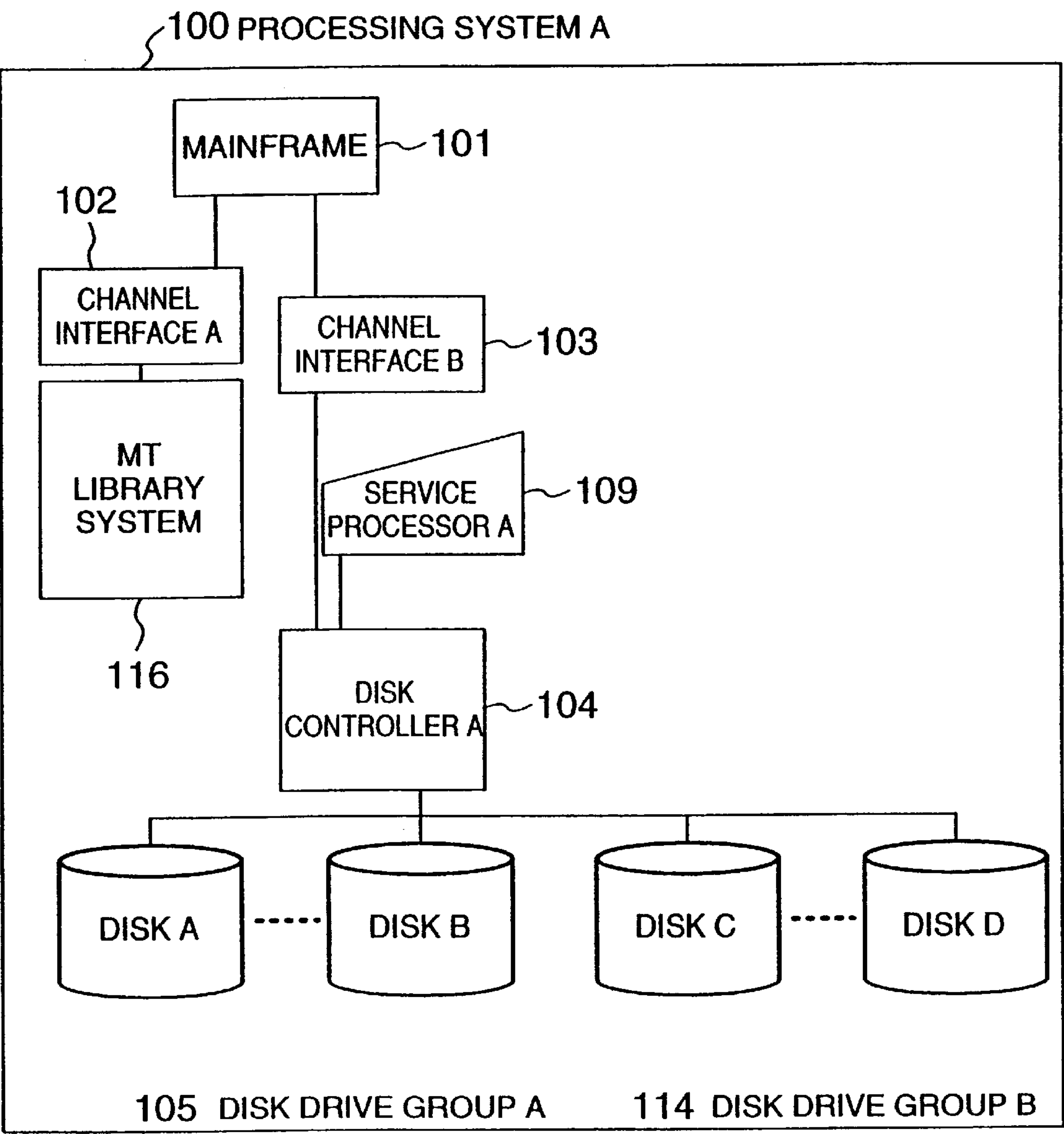


FIG.7

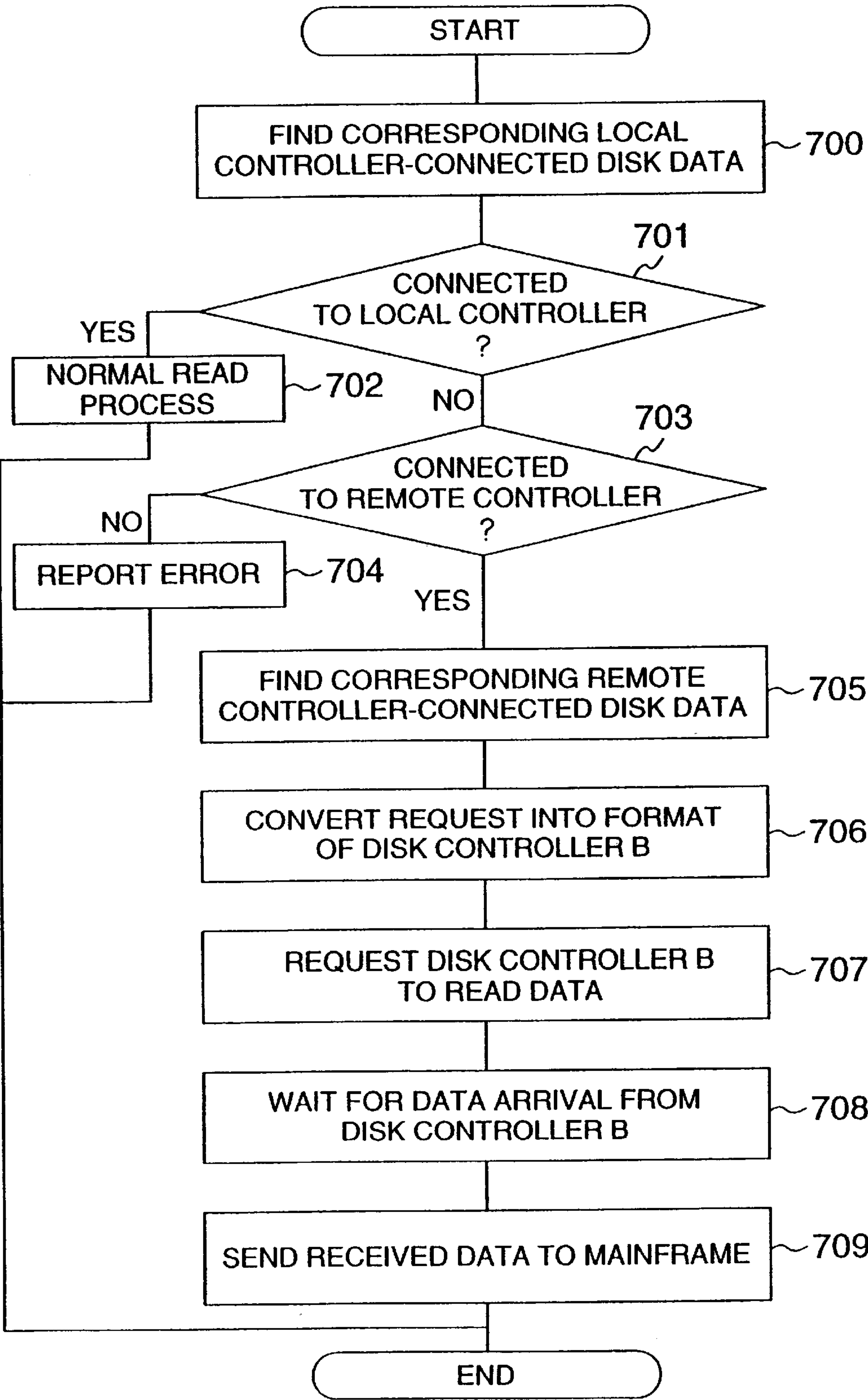
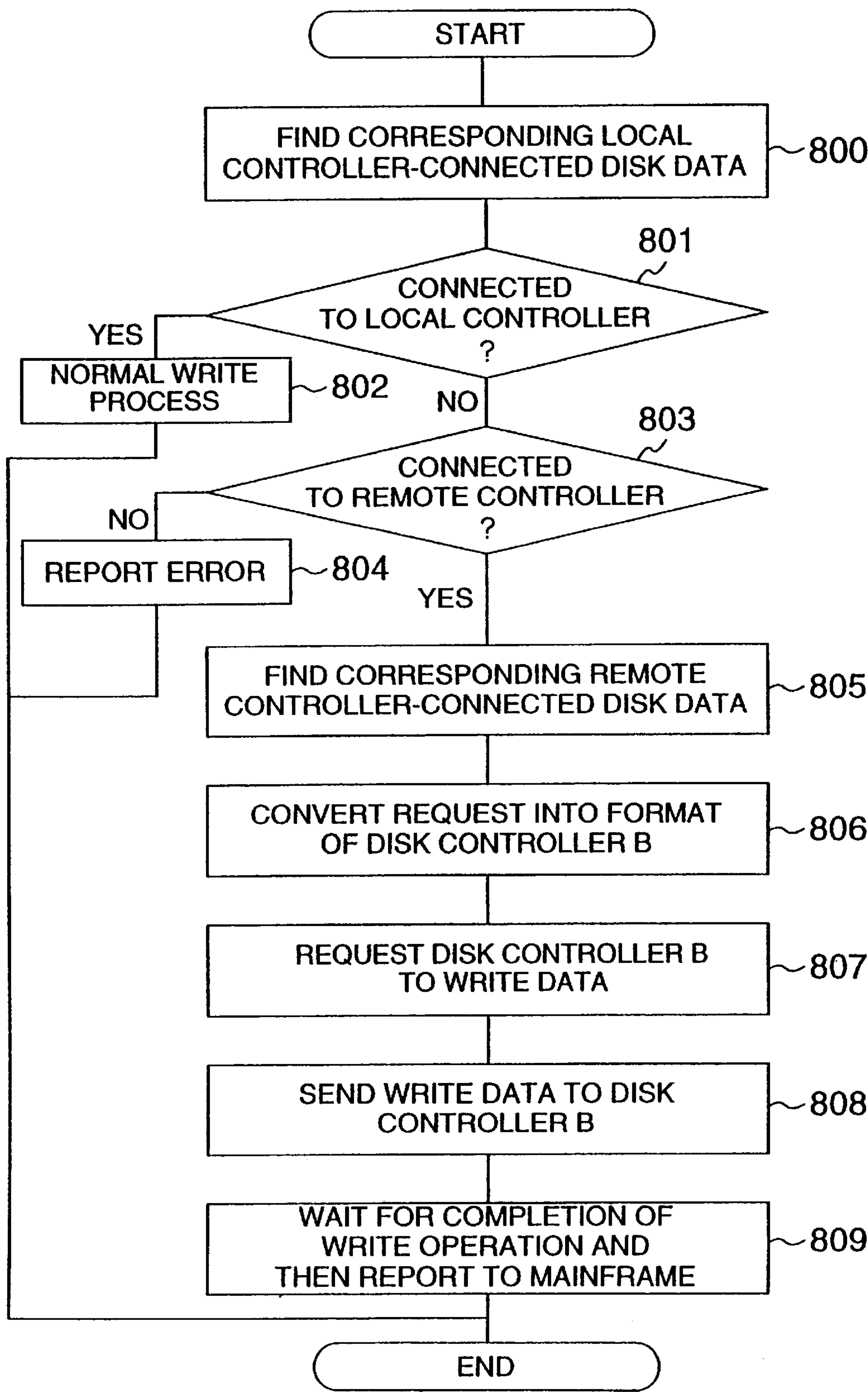


FIG.8



**COMMUNICATIONS SYSTEM/METHOD
FROM HOST HAVING VARIABLE-LENGTH
FORMAT TO VARIABLE-LENGTH FORMAT
FIRST I/O SUBSYSTEM OR FIXED-LENGTH
FORMAT SECOND I/O SUBSYSTEM USING
TABLE FOR SUBSYSTEM DETERMINATION**

BACKGROUND OF THE INVENTION

The present invention relates to a heterogeneous computer system comprising a host computer and a plurality of I/O subsystems, and more in particular to a method for making it possible to back up the data stored in a memory between a host computer and an I/O subsystem which cannot be directly connected due to the difference in access interface, and a heterogeneous computer system including a plurality of I/O subsystems having different access interfaces connected to the system and the host computer.

In mainframes, a large scale of memory hierarchy (storage hierarchy) including a combination of a plurality of external memories having different processing speeds and different storage capacities is accompanied by a satisfactory data management function and an overall storage management function intended to support an optimum data arrangement and an efficient operation. The IBM's DFSMS (Data Facility Storage Management Subsystem) is an example, which is described in detail in "IBM SYSTEMS JOURNAL", Vol. 28, No. 1, 1989, pp. 77-103.

The disk data of the I/O subsystem of the mainframe computer system having the above-mentioned management function can be backed up in a medium such as a magnetic tape or a magnetic tape library capable of storing a large quantity of data with a low cost per bit.

An open system such as a personal computer or a work station, unlike the mainframe, is not equipped with a magnetic tape or a magnetic tape library capable of storing a large quantity of data.

Generally, in an open system such as a personal computer or a work station, a disk is accessed in accordance with a fixed-length record format, while the mainframe accesses a disk in accordance with a variable-length record format called the count key data format.

As a result, the disk subsystem for the mainframe computer is often configured independently of the disk subsystem for the open system.

On the other hand, a technique for transmitting and receiving data between I/O subsystems is disclosed in U.S. Pat. No. 5,155,845.

In a disk subsystem for an open system and a disk subsystem for a mainframe computer which use different host computers, the back-up and other functions are independently operated and managed.

In view of the fact that the open system lacks a medium such as a magnetic tape or a magnetic tape library capable of storing a larger quantity of data, as described above, it is effective to back up the data in the I/O subsystem of the mainframe.

An ordinary disk system for the open system, however, cannot be connected directly to the mainframe due to the difference in the interface thereof.

U.S. Pat. No. 5,155,845 fails to disclose how to process the read/write operation for a storage system not directly connected to a host computer.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a method and a system for backing up data stored in a memory

between a host computer and an I/O subsystem that cannot be connected directly to each other due to the difference in access interface.

Specifically, an object of the invention is to provide a method and a system for backing up data stored in an I/O subsystem of an open system from a mainframe not directly connected to the I/O subsystem.

Another object of the invention is to provide a method and a computer system in which a mainframe is capable of accessing a memory of an I/O subsystem of an open system not directly connected to the mainframe.

Still another object of the invention is to provide a system and a method of access in which two or more I/O subsystems having different interfaces can be connected to a mainframe.

In order to achieve the above-mentioned objects, according to one aspect of the present invention, there is provided a heterogeneous computer system comprising a first host computer, a first I/O subsystem directly connected to the first host computer by an interface of variable-length record format and including at least one external memory, a second host computer, a second I/O subsystem directly connected to the second host computer by an interface of fixed-length record format and including at least one external memory, and a communication unit for connecting the first I/O subsystem to the second I/O subsystem;

wherein the first I/O subsystem includes a table for storing a device address of an external memory, data indicating one of the external memory of the first I/O subsystem and the external memory of the second I/O subsystem to which the device address is assigned, and a device address of the external memory in the second I/O subsystem the device address is assigned to the external memory of the second I/O subsystem; and

wherein upon receipt of a read/write request conforming to the interface of variable-length record format from the first host computer and including an address of an external memory to be read from or written into, and upon decision, with reference to the table, that the external memory address included in the read/write request is assigned to the external memory included in the second I/O subsystem, the first I/O subsystem converts the read/write request into a second read/write request conforming to the interface of fixed-length record format and sends the second read/write request to the second I/O subsystem.

According to another aspect of the invention, there is provided a heterogeneous computer system comprising a first host computer, a first I/O subsystem directly connected to the first host computer by an interface of variable-length record format and including at least one external memory, a back-up system connected to the first host computer, a second host computer, a second I/O subsystem directly connected to the second host computer by an interface of fixed-length record format and including at least one external memory, and a communication unit for connecting the first I/O subsystem to the second I/O subsystem;

wherein the first host computer includes a means for issuing to the first I/O subsystem a read request conforming to the interface of variable-length record format and containing the address of an external memory from which data is to be read, and backing up the data received from the first I/O subsystem into the back-up system;

wherein the first I/O subsystem includes a table for storing the device address of an external memory, data indicating that one of the external memory of the first and

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the second I/O subsystems to which the device address is assigned, and the device address of the external memory in the second I/O subsystem when the first device address is assigned to the external memory of the second I/O subsystem; and

wherein upon receipt from the first host computer of a read request conforming to the interface of variable-length record format including an external memory address to be read, and upon decision, with reference to the above-mentioned table, that the device address of the memory address included in the read request is assigned to the external memory included in the second I/O subsystem, the first I/O subsystem converts the read request into a second read request conforming to the fixed-length interface and sends the second read request to the second I/O subsystem while at the same time sending to the first host computer the data received from the second I/O subsystem.

According to still another aspect of the invention, there is provided a heterogeneous computer system comprising a first host computer, a first I/O subsystem directly connected to the first host computer by an interface of variable-length record format and including at least one external memory, a back-up system connected to the first host computer, a second host computer, a second I/O subsystem directly connected to the second host computer by an interface of fixed-length record format and including at least one external memory, and a communication unit for connecting the first I/O subsystem to the second I/O subsystem;

wherein the first host computer includes a means for issuing to the first I/O subsystem a write request conforming to the interface of variable-length record format including the address of an external memory into which data is to be written, and sending the data read from the back-up system to the first I/O subsystem;

wherein the first I/O subsystem includes a table containing a device address of the external memory, data indicating one of the external memories of the first and the second I/O subsystems to which the device address is assigned, and a device address of the external memory in the second I/O subsystem when the first device address is assigned to the external memory of the second I/O subsystem; and

wherein upon receipt from the first host computer of a write request conforming to the interface of variable-length record format including the device address of an external memory to be written into, and upon decision, with reference to the table, that the address of the external memory included in the write request is assigned to the external memory included in the second I/O subsystem, the first I/O subsystem converts the write request into a second write request conforming to the interface of fixed-length record format, sends the second write request to the second I/O subsystem while at the same time sending the data received from the first host computer to the second I/O subsystem.

According to yet another aspect of the invention, there is provided a heterogeneous I/O system for use with a host computer connected thereto, comprising a first I/O subsystem including at least one external memory, and a second I/O subsystem connected to the first I/O subsystem and including at least one external memory;

wherein the first I/O subsystem includes a table for storing a device address of an external memory, data indicating one of the external memories of the first and the second

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I/O subsystems to which the device address is assigned, and a device address of the external memory in the second I/O subsystem when the first device address is assigned to the external memory of the second I/O subsystem;

wherein upon receipt of a read/write request designating the device address of an external memory to be read from or written into by the host computer, and upon decision, with reference to the table, that the external memory address in the designated address is assigned to the external memory included in the second I/O subsystem, the first I/O subsystem sends the read/write request to the second I/O subsystem.

According to a further aspect of the invention, there is provided a heterogeneous I/O system for use with a host computer connected thereto, comprising a first I/O subsystem having an interface of variable-length record format and including at least one external memory, a second I/O subsystem having an interface of fixed-length record format and including at least one external memory, and a communication unit for connecting the first I/O subsystem to the second I/O subsystem;

wherein the first I/O subsystem includes a table for storing a device address of an external memory, data indicating one of the external memories of the first and the second I/O subsystems to which the device address is assigned, and a device address of the external memory in the second I/O subsystem when the first device address is assigned to the external memory of the second I/O subsystem; and

wherein upon receipt from the host computer of a read/write request conforming to the interface of variable-length record format including the address of an external memory to be read from or written into, and upon decision, with reference to the table, that the external memory address included in the read/write request is assigned to the external memory included in the second I/O subsystem, the first I/O subsystem converts the read/write request into a second read/write request conforming to the interface of fixed-length record format and sends it to the second I/O subsystem.

According to an embodiment of the invention, there is provided a heterogeneous computer system, wherein an I/O subsystem for an open system is connected to an I/O subsystem for a mainframe by a communication unit, wherein, in order to access data in the I/O subsystem for an open system from the mainframe for enabling the data in the disk connected to the I/O subsystem for the open system to be backed up in a magnetic tape library system; a table is prepared for assigning a vacant address of the memory in the local subsystem to the memory of the I/O subsystem for the open system; wherein a request of variable-length record format received from the mainframe is converted into a request of fixed-length record format for the open system; wherein the disk designated according to the table is accessed, and wherein the data thus obtained is sent to the mainframe and backed up in the back-up system.

This configuration can back up the data of an I/O subsystem for an open system in a back-up system under the management of a mainframe not directly connected to the particular I/O subsystem.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing a configuration of a heterogeneous computer system according to an embodiment of the present invention.

FIG. 2 is a block diagram showing a configuration of a heterogeneous computer system according to another embodiment of the invention.

FIG. 3 is a block diagram showing a configuration of a disk controller of the heterogeneous computer system shown in FIGS. 1 and 2.

FIG. 4 is a diagram showing a configuration of a local controller-connected disk data (table) for the systems shown in FIGS. 1 and 2.

FIG. 5 is a diagram showing a configuration of a remote controller-connected disk data (table) for the systems shown in FIGS. 1 and 2.

FIG. 6 is a diagram showing the interconnection of disk devices as viewed from the mainframe.

FIG. 7 is a diagram showing an example of the processing flow of a disk controller A in the case where the data in an I/O subsystem for an open system is backed up in an MT library system of the mainframe.

FIG. 8 is a diagram showing an example of the processing flow of a disk controller A in the case where data are restored in an I/O subsystem for an open system from an MT library system of the mainframe.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the invention will be described below with reference to the accompanying drawings.

FIG. 1 is a diagram showing a configuration of a computer system according to an embodiment of the invention.

A processing system A **100** includes a mainframe **101**, a channel interface A **102**, a channel interface B **103**, a magnetic tape (MT) controller **106**, a magnetic tape library controller **130**, a magnetic tape library **107**, a disk controller A **104**, a disk drive group A **105** and a service processor A **109**. A back-up processing device **162** and a restore processing device **164** are mounted on the mainframe **101**.

The mainframe **101** accesses the disk controller A **104** through the channel interface B **103** conforming with a variable-length record format called the count-key-data format.

The count-key-data format is a record format in which a record constituting a unit of read/write operation is configured of three fields including a count field, a key field and a data field.

A record ID is stored in the count field, a key data for accessing the record is stored in the key field, and the data used by an application program is stored in the data field.

In the description that follows, the magnetic tape (MT) controller **106**, the magnetic tape library controller **130** and the magnetic tape library **107** are collectively referred to as an MT library system **116**. The disk controller A **104** and the disk drive group A **105** constitute an I/O subsystem **10** connected to the mainframe **101**. In similar fashion, the disk controller B **113** and the disk drive group B **114** constitute an I/O subsystem **20** connected to a host **111** for an open system.

An optical disk or the like, as well as a magnetic disk, constitutes a rank of storage hierarchy connected through the channel interface. The following description refers to the case in which the MT library system **116** is connected.

The disk controller A **104** contains local controller-connected disk data **314** and remote controller-connected disk data **315**.

The local controller-connected disk data **314** and the remote controller-connected disk data **315** are data provided

for making it possible for the mainframe to access a disk device of the I/O subsystem not directly connected thereto. Specifically, the data **314** and **415** are a table for assigning a vacant address of the memory in the local I/O subsystem **10** for the processing system A to the memory of the I/O subsystem **20** for the processing system B so that the data in the I/O subsystem **20** for the processing system B can be accessed from the mainframe **101**. The data **314** and **315** will be described in detail later.

The processing system B **110** includes a host **111** for the open system, a SCSI (small computer system interface) **112**, the disk controller B **113**, the disk drive group B **114** and a service processor B **115**.

The host **111** for the open system accesses the disk controller B **113** through the SCSI **112** having a fixed-length record which is a unit of read/write operation.

The disk controller A **104** and the disk controller B **113** are connected by a communication line **108**. The communication line **108** can be, for example, a SCSI cable B **117**.

In the description that follows, the count-key-data format will be called the CKD format, and the fixed-length block format will be called an FBA (fixed block architecture) format.

Also, the record of the CKD format will be referred to as the CKD record, and the record of the FBA format will be referred to as the FBA record.

FIG. 2 is a diagram showing another example of a computer system according to the invention, in which a single I/O subsystem for the mainframe is connected to two or more I/O subsystems for an open system.

In a processing system X **120**, the interfaces of an open system host X **121** and a disk controller X **123** are connected to each other by a fiber channel interface **122**. The fiber channel interface **122** is an optical fiber cable which can increase the length of connection between a host and a control device.

In many case, however, a fiber channel interface based on SCSI is employed between a host and a control device.

Also, an interface such as a fiber channel interface X **126** can be used to connect a disk controller X **123** and the disk controller B **113**.

The data back-up system in the configuration of FIG. 2 is an expansion of the data back-up system in the configuration of FIG. 1.

The fundamental operation of each system is such that the mainframe **101** and the hosts **111** and **121** for the open system access the magnetic tape library **107** constituting an external memory or the disk drive group A **105**, the disk drive group B **114** and the disk drive group X **124** through each interface.

The process in the mainframe **101** establishes a route to the data stored externally through each interface under the control of an arbitrary operating system such as Hitachi's VOS3 (virtual-storage operating system 3) for supporting the channel interface, while the process in the host for the open system establishes a route to the externally-stored data through each interface under the control of an arbitrary operating system such as UNIX (a registered trade mark owned by X/Open in U.S.A. and other countries) for supporting the SCSI.

FIG. 3 is a diagram showing a configuration of the disk controller A **104**.

The disk controller A **104** includes a MPU **302** for executing a control system process **307** of the disk controller, a memory **301**, a host data transfer device **303**, a

disk/cache device **304**, an inter-I/O subsystem data transfer device **305**, a data transfer device **306** and a control bus **308** for connecting these devices.

The control system process **307** operates in a multitask or multiprocessor environment.

The memory **301** includes various microprograms **312** and various data **313**.

Especially, the disk controller A **104** has stored therein the local controller-connected data **314** and the remote controller-connected disk data **315**, as described above with reference to FIG. 1.

The disk controller B **113** and the disk controller X **123** have a configuration similar to the disk controller A **104** and will not be described in detail.

The disk controller B **113** and the disk controller X **123**, however, are not required to contain the local controller-connected disk data **314** and the remote controller-connected disk data **315**.

The local controller-connected disk data **314** is the data indicating the connections of the controllers and the like, and stored in the memory **301** of the disk controller A **104**. The local controller-connected disk data **314** exists as the data corresponding to each disk device.

The local controller-connected disk data **314** is shown in FIG. 4.

The device address **400** is an identifier (ID) for discriminating a disk device to be read from or written into by a host computer such as the mainframe **101**, and is the data also contained in the read/write request issued by the host computer such as the mainframe **101**.

Local controller connection data **401** is the data indicating whether or not the disk drive corresponding to the controller-connected disk data **314** is actually connected to a controller.

A remote controller connection pointer **402** indicates whether or not the controller-connected disk data **314** is assigned to a disk drive connected to a remote controller.

In the case where the such data is assigned to a disk drive connected to a remote controller, the pointer indicates a corresponding remote controller-connected disk data **315**. Otherwise, the pointer assumes a null value.

In the case where the remote controller connection pointer **402** is valid (i.e. in the case where the particular device address **400** is assigned to a disk device connected to a remote controller), it represents the state in which the local controller connection data **401** is not assigned.

In the case where the remote controller connection pointer **402** is invalid (i.e. in the case where the device address **400** is not assigned to a disk drive connected to a remote controller), on the other hand, the local controller connection data **401** may indicate the state of no-assignment.

In other words, the device address **400** may be assigned to neither a disk device connected to a local controller nor a disk device connected to a remote controller.

An attribute **403** is the data unique to a device including the interface, the function, the data format and the block length of the disk drive.

The local controller-connected disk data **315** shown in FIG. 5 is the data corresponding to a disk drive not directly connected to the disk controller A **104**.

It follows therefore that the remote controller-connected disk data **315**, on the other hand, is pointed to by any one of the local controller-connected disk data **314**.

A connection controller address **500** represents the address of a controller connected with a disk device corre-

sponding to the remote controller-connected disk data **315**. According to this embodiment, the address of the disk controller B **113** is stored as the connection controller address **500**.

A disk address **501** represents the address assigned in the controller actually connected to a corresponding disk drive.

The local controller-connected disk data **314** and the remote controller-connected disk data **315** are set from the service processor **109**.

According to this embodiment, the mainframe **101** recognizes that the disk drive group B **114** (disks C and D) is also connected to the disk controller A **104** through the disk controller B **113**, as shown in FIG. 6, taking advantage of the local controller-connected disk data **314** and the remote controller-connected disk data **315** shown in FIGS. 4 and 5.

This is because of the fact that the vacant address of disk drive available in the disk controller A **104** is assigned by the disk controller A **104** to a disk drive of the I/O subsystem for an open system.

Now, the back-up processing will be described with reference to FIGS. 1, 7 and 8.

Specifically, in FIG. 1 the back-up process **162** on the mainframe **101** causes the data in the disk device group B **114** of the open system of the processing system B to be backed up in the MT library system **116** through the disk controller A **104** and the mainframe **101** of the processing system A.

Conversely, the data backed up in the MT library system **116** is restored in the disk drive group B **114** of the open system of the processing system B through the mainframe **101** and the disk controller A **104** of the processing system A.

The back-up operation and the restoration described above are executed in response to a command from the mainframe **101**.

First, an explanation will be given of the case in which the data in the disk drive group B **114** of the open system for the processing system B is backed up in the MT library system **116** through the disk controller A **104** and the mainframe **101** of the processing system A.

As already described above, the mainframe **101** has recognized that the disk drive group B **114** (disks C and D) are also connected to the disk drive A **104**.

Therefore, the operation of the mainframe **101**, which is simply to issue a read request to the disk controller A **104** and back up the received data in the MT library system **116**, will not be described specifically.

In the case of backing up data into the MT library system **116**, the mainframe **101** issues a read request to the disk controller A **104**. The disk controller A **104** executes the process in accordance with the flowchart of FIG. 7 in response to a read request from the mainframe **101**.

First, step **700** finds out a corresponding local controller-connected disk data **314** from the address of the disk drive designated in the read request.

Step **701** checks whether the designated disk drive is connected to the disk controller A **104** or not.

In the case where the disk drive is connected to the disk controller A **104**, step **702** reads the corresponding data from the particular disk drive.

In the case where the disk drive is not connected to the disk controller A **104**, in contrast, step **703** checks whether the designated disk drive is connected to a remote disk controller (disk controller B **113**). In other words, it checks

whether the remote controller connection pointer **402** assumes a null value.

In the case where the check result shows that the remote controller connection pointer **402** assumes a null value indicating that the designated disk drive is not connected to the remote disk controller, an error is reported in step **704**.

The operation specifically related to the invention is represented by step **705** and subsequent steps executed in the case where a designated disk drive is connected to a remote disk controller (disk controller **B 113**).

First, in the case where the check result shows that the remote controller connection pointer **402** does not assume the null value indicating that the designated disk drive is connected to a remote disk controller, step **705** finds out the remote controller-connected disk data **315** corresponding to the designated disk drive based on the remote controller connection pointer **402**. Then, the address of the disk controller (disk controller **B 113**) actually connected with the designated disk drive and the address of the disk drive in the disk drive group **B** connected to the particular disk controller **B 113** are acquired on the basis of the remote controller-connected disk data **315** found as above.

Then, step **706** converts the address of the data to be read which has been received in the read request into the format of the disk drive connected to the disk controller **B 113**.

In a read/write request from the mainframe **101**, the address of data to be read or written is normally designated by the cylinder number, the head number and the record number according to the CKD format.

The record address expressed by the cylinder number, the head number and the record number will hereinafter be called CCHHR.

The disk drive connected to the disk controller **B 113**, on the other hand, has an access interface designated by LBA (logical block address) in accordance with the FBA format.

Consequently, step **706** converts the access address of the data to be read from CKD format to FBA format.

The conversion formula is given, for example, by

$$LBA = (CC \times \text{number of heads} + HH) \times \text{track length} + \text{record number} \times \text{record length}$$

According to this embodiment, the disk controller **A 104** and the disk controller **B 113** may have the same interface, in which case the conversion of the input/output interface format is not required.

Step **707** issues a request to the disk controller **B 113** to read the data from the area of the corresponding disk drive calculated in step **706**.

Step **708** waits for the arrival of the requested data from the disk controller **B 113**.

Step **709** sends the data received from the disk controller **B 113** to the main frame **101** thereby to complete the process.

The disk controller **B 113** simply reads the data requested by the disk controller **A 104** from a disk drive, and sends it to the disk controller **A 104**. This process, therefore, is not described specifically in the processing flow.

Next, an explanation will be given of a case in which data backed up in the MT library system **116** is restored by the restore process **164** on the mainframe **101** in the disk drive group **B 114** of the open system of the processing system **B** through the disk controller **A 104** and the mainframe **101** of the processing system **A**.

As described already above, the mainframe **101** has recognized that the disk drive group **B 113** (disks **C** and **D**) are also connected to the disk controller **A 104**.

Therefore, no explanation will be given of the operation of the mainframe **101** which is simply to issue a write request to the disk controller **A 104** to write the data read from the MT library system **116**.

Upon receipt of a write request from the mainframe **101**, the disk controller **A 104** executes the process in accordance with the flowchart of FIG. **8**.

In the processing flow of FIG. **8**, steps **800** to **801**, **803** to **806** are similar to steps **700** to **701**, **703** to **706** in FIG. **7**, respectively, and therefore will not be explained. Also, step **802** is normally the write operation, since the request from the mainframe **101** is a write request. Only the parts different from FIG. **7** will be described below.

Step **807** issues a request to the disk controller **B 113** to write data in the area of the corresponding disk drive calculated in step **807**.

Next, in step **808**, the write data is received from the mainframe **101** and sent to the disk controller **B 113**.

Then, step **809** waits for a report on the completion of the write request from the disk controller **B 113**, and upon receipt of the completion report, sends it to the mainframe **101** thereby to complete the process.

The disk controller **B 113** simply reads the data requested by the disk controller **A 104** from the corresponding disk drive and sends it to the disk controller **A 104**. The related processing flow, therefore, is not shown specifically.

The foregoing description concerns a system for backing up data of the disk drive group **B 114** of the open system of the processing system **B** by the processing system **A**. As another embodiment, a heterogeneous I/O subsystem can be configured in which only the disk controller **B** and the disk drive group **B** are connected to the processing system **A** and the mainframe is connected with two I/O subsystems having different interfaces. In such a case, three or more instead of two I/O subsystems can be connected.

The above-mentioned embodiment permits data to be backed up between I/O subsystems having different access interfaces.

As a result, data stored in an I/O subsystem for an open system can be backed up into an I/O subsystem for the mainframe.

Also, the back-up mechanism of the mainframe includes a large-capacity, high-performance and high-reliability MT library system. The data of the I/O subsystem for an open system, therefore, can be backed up by a mainframe back-up mechanism high in performance and reliability.

Further, different I/O subsystems can be connected to the mainframe.

What is claimed is:

1. A heterogeneous computer system comprising:

a first host computer;

a first I/O subsystem connected by an interface of variable-length record format to said first host computer and including at least one external memory;

a second host computer;

a second I/O subsystem connected to said second host computer by an interface of fixed-length record format and including at least one external memory; and

a communication unit for connecting said first I/O subsystem to said second I/O subsystem;

wherein said first I/O subsystem includes:

a table for storing a device address of an external memory, data indicating one of said first I/O subsystem and said second I/O subsystem to which said device address is assigned, and a device address of said external memory in said second I/O subsystem

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- when said device address is assigned to the external memory of said second I/O subsystem: and
- a means for receiving from said first host computer a first read/write request conforming to said interface of variable-length record format including the address of the external memory to be read from or written into, and upon decision, with reference to said table, that said address of said external memory included in said first read/write request is assigned to the external memory included in said second I/O subsystem, converting said first read/write request into a second read/write request conforming to said interface of fixed-length record format and sending said second read/write request to said second I/O subsystem.
2. A heterogeneous computer system comprising:
- a first host computer;
- a first I/O subsystem connected by an interface of variable-length record format to said first host computer and including at least one external memory;
- a back-up system connected to said first host computer;
- a second host computer;
- a second I/O subsystem connected to said second host computer by an interface of fixed-length record format and including at least one external memory; and
- a communication mechanism for connecting said first I/O subsystem to said second I/O subsystem;
- wherein said first host computer includes:
- a means for issuing to said first I/O subsystem a read request conforming to said interface of variable-length record format including the address of the external memory from which data is to be read, and backing up the data received from said first I/O subsystem in said back-up system;
- wherein said first I/O subsystem includes:
- a table for storing a device address of an external memory, data indicating one of said first I/O subsystem and said second I/O subsystem to which said device address is assigned, and a device address of said external memory in said second I/O subsystem when said device address is assigned to the external memory of said second I/O subsystem;
- a means for receiving from said first host computer a first read request conforming with said interface of variable-length record format including the address of the external memory to be read from, and upon decision, with reference to said table, that said address of said external memory included in said first read request is assigned to the external memory included in said second I/O subsystem with reference to said table, converting said first read request into a second read request conforming to said interface of fixed-length record format, sending said second read request to said second I/O subsystem, and sending the data received from said second I/O subsystem to said first host computer; and
- a means for backing up said data received by said first host computer in said back-up system.
3. A heterogeneous computer system comprising:
- a first host computer;
- a first I/O subsystem connected by an interface of variable-length record format to said first host computer and including at least one external memory;
- a back-up system connected to said first host computer;
- a second host computer;

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- a second I/O subsystem connected to said second host computer by an interface of fixed-length record format and including at least one external memory; and
- a communication unit for connecting said first I/O subsystem to said second I/O subsystem;
- wherein said first host computer includes a means for issuing to said first I/O subsystem a write request conforming to said interface of variable-length record format including the address of the external memory to be written into, and for sending the data read from said back-up system to said first I/O subsystem;
- wherein said first I/O subsystem includes:
- a table for storing a device address of an external memory, data indicating one of said first I/O subsystem and said second I/O subsystem to which said device address is assigned, and a device address of said external memory in said second I/O subsystem when said device address is assigned to the external memory of said second I/O subsystem;
- a means for receiving from said first host computer a first write request conforming to said interface of variable-length record format including the address of the external memory to be written into, and upon decision, with reference to said table, that said address of said external memory included in said first write request is assigned to the external memory included in said second I/O subsystem with reference to said table, converting said first write request into a second write-request conforming to said interface of fixed-length record format, sending said second write request to said second I/O subsystem, and sending the data received from said first host computer to said second I/O subsystem.
4. A heterogeneous input/output system for use with a host computer connected thereto, comprising:
- a first I/O subsystem having an interface of variable-length record format and including at least one external memory, and a second I/O subsystem having an interface of fixed-length record format and including at least one external memory, and a communication unit for connecting said first I/O subsystem to said second I/O subsystem;
- wherein said first I/O subsystem includes:
- a table for storing a device address of an external memory, data indicating one of said first I/O subsystem and said second I/O subsystem to which said device address is assigned, and a device address of said external memory in said second I/O subsystem when said device address is assigned to the external memory of said second I/O subsystem, and
- a means for receiving a read/write request from said host computer conforming to said interface of variable-length record format designating an address of the external memory to be read from or written into, and upon decision, with reference to said table, that said address of said external memory designated in said read/write request is assigned to the external memory included in said second I/O subsystem, converting is said read/write request into a second read/write request conforming to said fixed-length record format and sending said second read/write request to said second I/O subsystem.
5. A method of accessing an external memory for a heterogeneous computer system comprising a first host computer, a first I/O subsystem connected by an interface of variable-length record format to said first host computer and

including at least one external memory, a second host computer, a second I/O subsystem connected to said second host computer by an interface of fixed-length record format and including at least one external memory, and a communication unit for connecting said first I/O subsystem to said second I/O subsystem, said method comprising the steps of:

storing in an internal table of said first I/O subsystem a device address of an external memory, data indicating the external memory of that one of said first I/O subsystem and said second I/O subsystem to which said device address is assigned, and a device address of said external memory in said second I/O subsystem when said device address is assigned to the external memory of said second I/O subsystem; and

said first I/O subsystem receiving from said first host computer a read/write request conforming to said interface of variable-length record format including the address of said external memory to be read from or written into and deciding, with reference to said table, whether the address of the external memory included in said read/write request is assigned to the external memory included in said second I/O subsystem; and converting said read/write request into a second read/write request conforming to the interface of fixed-length record format and sending said second read/write request to said second I/O subsystem when said address of said external memory is assigned to said external memory included in said second I/O subsystem.

6. A method of backing up data in a heterogeneous computer system comprising a first host computer, a first I/O subsystem connected by an interface of variable-length record format to said first host computer and including at least one external memory, a back-up system connected to said first host computer, a second host computer, a second I/O subsystem connected to said second host computer by an interface of fixed-length record format and including at least one external memory, and a communication unit for connecting said first I/O subsystem to said second I/O subsystem, said first host computer including a means for issuing a read request to said first I/O subsystem and backing up the data received from said first I/O subsystem in said back-up system, said method comprising the steps of:

storing in an internal table of said first I/O subsystem a first device address of an external memory, data indicating the external memory of that one of said first I/O subsystem and said second I/O subsystem to which said first device address is assigned, and a second device address of said external memory in said second I/O subsystem when said first device address is assigned to the external memory of said second I/O subsystem; and said first I/O subsystem receiving from said first host computer a read request conforming to said interface of variable-length record format including the address of said external memory to be read from and deciding, with reference to said table, whether the address of the external memory included in said read request is assigned to the external memory included in said second I/O subsystem;

converting said read request into a second read request conforming to the interface of fixed-length record format and sending said second read request to said second I/O subsystem when said address of said external memory is assigned to said external memory included in said second I/O subsystem;

said first I/O subsystem receiving the read data from said second I/O subsystem, and sending said received read data to said first host computer; and

backing up the data received by said first host computer in said back-up system.

7. A method of restoring the back-up data in a heterogeneous computer system comprising a first host computer, a first I/O subsystem connected by an interface of variable-length record format to said first host computer and including at least one external memory, a back-up system connected to said first host computer, a second host computer, a second I/O subsystem connected to said second host computer by an interface of fixed-length record format and including at least one external memory, and a communication unit for connecting said first I/O subsystem to said second I/O subsystem, said first host computer including a means for issuing a write request to said first I/O subsystem and sending the data read from said back-up system to said first I/O subsystem, said method comprising the steps of:

storing in an internal table of said first I/O subsystem a first device address of an external memory, data indicating the external memory of that one of said first I/O subsystem and said second I/O subsystem to which said first device address is assigned, and a second device address of said external memory in said second I/O subsystem when said first device address is assigned to the external memory of said second I/O subsystem; and

said second I/O subsystem receiving from said first host computer a write request conforming to said interface of variable-length record format including the address of an external memory to be written into and deciding, with reference to said table, whether the external memory address included in said write request is assigned to the external memory included in said second I/O subsystem;

converting said write request into a second write request conforming to the interface of fixed-length record format and sending said second write request to said second I/O subsystem when said external memory address is assigned to said external memory included in said second I/O subsystem; and

said first I/O subsystem sending the data read from said back-up system and received from said first host computer to said second I/O subsystem.

8. A method of accessing an external memory in a heterogeneous input/output system for use with a host computer connected thereto, comprising a first I/O subsystem having an interface of variable-length record format and including at least one external memory, a second I/O subsystem having an interface of fixed-length record format and including at least one external memory, and a communication unit for connecting said first I/O subsystem to said second I/O subsystem, said method comprising the steps of:

storing in an internal table of said first I/O subsystem a first device address of an external memory, data indicating one of said first I/O subsystem and said second I/O subsystem to which said first device address is assigned, and a second device address of said external memory in said second I/O subsystem when said first device address is assigned to the external memory of said second I/O subsystem;

said first I/O subsystem receiving from said host computer a read/write request conforming to said interface of variable-length record format including the address of an external memory to be read from or written into, and deciding, with reference to said table, whether the external memory address included in said read/write request is assigned to the external memory included in said second I/O subsystem; and

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converting said read/write request into a second read/write request conforming to said interface of fixed-length record format and sending said second read/write request to said second I/O subsystem when said

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external memory address is assigned to the external memory included in said second I/O subsystem.

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